Winter 2000 ⁂ Volume 1 ⁂ Number 3

Why the Earth Observing System Matters to All of Us

by Steven W. Running, Professor, University of Montana, reprinted with permission

At the end of this millennium it is appropriate for us to reflect upon the world we are passing on to our children. We are the first generation in human history with the capacity to impact the entire global system. Atmospheric CO_2 concentrations have been measured carefully since 1957 at Mauna Loa, and the increase has been steady at about 0.3% per year since then, a direct result of fossil fuel combustion. Atmospheric CO_2 in itself is not dangerous, it actually helps plants grow faster. But scientists see it as a canary in the coal mine, the leading indicator of other global scale human impacts on the biosphere, the sum total of living organisms on the land and in the oceans. Whether the collective impacts of humans on Earth are benign or on a trajectory to future disaster is an ethical question we must now confront. However, studying the entire Spaceship as a functioning Earth System had never been tried before, until now.

In July 1983, NASA published with little fanfare the report of a small group of scientists aptly named Land-Related Global Habitability Science Issues. This brainstorming by about 20 scientists, including myself, was a first attempt to think how the entire Earth could be monitored carefully and continuously to evaluate global change trends. NASA spent the rest of the 1980s designing a system to measure global habitability, and the Earth Observing System, EOS, was conceived in 1990. On December 16, 1999, maybe fittingly at the end of this millennium, we will launch the first satellite designed to fulfill this vision. The one line summary of the purpose of EOS is to find out, "Is the current human occupancy and activity of planet Earth sustainable?"

It is the moral imperative of our generation to pass on to our children and grandchildren a world that is equal in habitability to the world our parents gave to us. The problem is that as the global population passes 6 billion people, even if individual resource consumption stayed constant, impacts on the biosphere will increase. However, we seem to be living in bigger houses, driving fancier cars, and flying off to more vacations than our parents did. So per capita resource consumption is not staying constant at all, but increasing. And the developing world is desperately trying to catch up to these living standards of the developed countries. Many developing countries are also making the same mistakes of "development at whatever the environmental cost" that we made 30 years ago. We learned back then that rivers catching on fire and air pollution that forces schoolchildren to stay in at recess is unacceptable. The progress in cleaning up regional pollution in the United States has been remarkable in the last few decades. But now at the end of the 1990s, as we see a globalized economy, we also now see a globally interconnected environment.

Documenting and monitoring biospheric health, just like human health, should not be a political topic. Biospheric health, and more specifically the sustainability of human life on planet Earth, is a topic that cuts across liberals and conservatives, Republicans and Democrats. We all want the best for our grandchildren, and to pass on to them a livable world. However, until now, global biospheric health has been largely unmeasurable, so discussions and policy development have been handicapped by a paucity of data. The purpose of EOS is to provide this factual information on trends of change in our biosphere. How we interpret these data, and the course of action we embark on in the next millennium, will be a critical political topic. If global change trends turn out to be relatively

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The Heart of the DAAC

System Execution (a.k.a. Operations)

by Lee Kyle et al.

Just as the heart drives the vital blood circulation throughout the body, a Distributed Active Archive Center (DAAC) operating system pumps important environmental data into and out of the Earth Science Archives. But at the Goddard Space Flight Center Earth Science (GES) DAAC, the operating system is more than just a pump. It ingests raw environmental data, does some science processing itself and receives other processed data from various sources, archives the data, and finally distributes it to the user community. As required, it also supplies the lower level products back to the science processing teams when revised science products are being produced. Although highly computerized, it has and needs an expert staff, led by Catherine Harnden, to ensure that it operates properly. During the past year the Operations Staff carefully trained to be able to handle the twenty-fold increase in data flow that started coming to it in January 2000 from the Terra satellite. They have also participated in the fine tuning of the system. Almost all of these data are associated with the Moderate Resolution Imaging Spectrometer (MODIS).

The GES DAAC actually has three operating systems or hearts. Often when the GES DAAC has taken on a major new task it has added a new operating system to handle the new task while the old system continues to handle the continuing tasks. This procedure maintains an uninterrupted flow of old line data products to our customers. The original V0 system ingests, archives, and distributes near real time SeaWiFS, AVHRR, CZCS, DAO, TOMS, TOVS, and UARS data products. The V1 operating system was added when the GES DAAC was given responsibility for archiving the Tropical Rainfall Measuring Mission (TRMM) data products. The TRMM data stream more than doubled the data handled by the GES DAAC and this warranted a separate system. GES DAAC staff constructed both the V0 and V1 systems. (See the Data Products section of this newsletter for a brief description of these products.)

The Terra data stream increases the data flow by roughly a factor of 20. To handle this large increase, a new V2 system was put in place. The basic V2 system was planned and developed by the Earth Science Data and Information System (ESDIS) project of NASA Goddard Space Flight Center. They named it the Earth Observing System Data and Information System Core System (ECS). Thus both names, "V2 system" and "ECS," are used for it, but V2 refers to only the GES DAAC system while ECS can have wider connotations. The science algorithms to produce MODIS Earth located radiances in scientific units, and some other science products, were developed by the MODIS science team and incorporated into the V2 system by the GES DAAC Science Software Integration and Test team led by Bruce Vollmer. The V2 system also has some GES DAAC unique extensions, which were added by the Engineering group headed by Chris Lynnes. After intensive preparation and training in 1999, a prelaunch Operations Readiness Review declared the GES DAAC ECS (V2) launch ready.

The Operations group is divided into two major sections. One section, led by Mark Fuerst and Tony Paruzynski, operates the V2 system while the other section, led by Liz Kennedy, operates both the V0 and V1 systems.

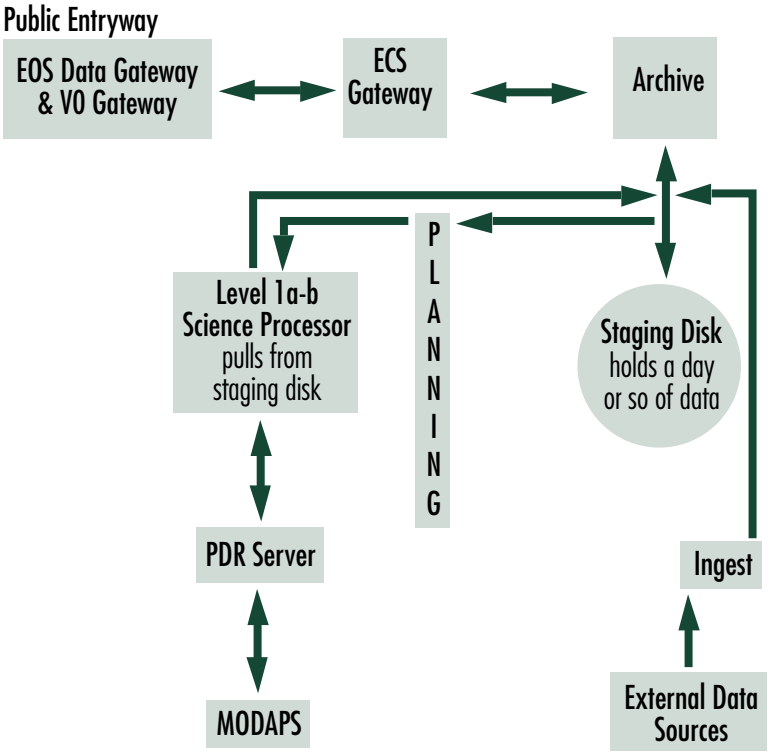
The V2 (ECS) System

The GES DAAC receives the MODIS Level 0 data and produces the Levels 1A and 1B science products (Earth located, calibrated radiances) and cloud mask and atmospheric profile products. These

products are archived and all but the Levels 0 and 1A data are sent on to the MODIS Processing System (MODAPS), which produces the higher level science products and returns the MODIS ocean color, sea surface temperature, and additional atmospheric science products to the GES DAAC for archive and distribution. Other ancillary data sets needed for processing are also archived. One of these is the assimilated weather data set produced by the Goddard Data Assimilation Office. The most important responsibility, as always, is the distribution of these data to the working science teams and to the general public. The data products are released to the public after the science teams have validated and characterized their science content.

Data Flow

In the diagram above right, the general public deals only with the Archive, as indicated on the top row. On the bottom right, raw data and ancillary data sets are ingested into the DAAC Archive. On the middle on the left side, low level MODIS science processing is carried out. These products are both archived and also sent on to MODAPS where the higher level science products are produced. The MODAPS products are sent, as appropriate, to archive at the GES DAAC, EDC (EROS Data Center; this is the Land Processes DAAC), or National Snow and Ice Data Center (NSIDC). The GES DAAC also sends out data subsets to subscribers who have signed up to receive specified data subsets as soon as they are available. The Planning module in the center keeps track of and regulates internal processing and data flow activities.



Archive activities:

1. Store the data.
2. Check subscriptions (external and internal).
3. Notify Planning module of data arrival and also notify any science subscribers.
4. Planning checks off data and releases any new jobs it can to processing.
5. Processing queue works: given the resources currently available (CPU, memory, and time for the job) it checks the resource profile and priority of the jobs in the queue and starts the highest priority job that fits in the system at that time.

V2 System's Three Modes of Operation

OPS	TS1	TS2
Normal operations	Science System Integration and Testing (SSI&T) of the science algorithm software into the system	Testing of new ECS code versions

The V2 system can operate all three modes simultaneously, but doing this has some impact on the speed of the system.

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modest, then only small adjustments in social behavior may be necessary. However, if impacts appear to be harmful and accelerating at an unpredictable pace, how can we ignore these early warnings in good conscience? It is essential the new political discussion be based on facts, not conjecture. These are lofty, long-range, visionary objectives, similar intellectually to searching for other life in the universe. But global habitability has more immediate significance to us all. Let us hope that EOS allows us to start the new millennium with an enlightened understanding of the changing biosphere.

The Heart of the DAAC
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Data Flow Volumes

The present V2 system is scaled to handle 1X of data in and 1X of data out per day, where X=430 GB. The present plan is that once MODIS and the various data processing systems are in full operations, 1X of data products will come into the DAAC for archiving each day. The MODIS level 0 raw inflow will amount to 70 GB per day of day of data. Changes in data format plus the production of numerous data products plus the ingest of some ancillary data will expand this to 430 GB per day. An outflow of 1X will go to various customers, half will be sent electronically and half will be shipped on media (8mm tapes). The GES DAAC uses D3 tapes for archive data storage and has a limited number of D3 tape drives. This is a limiting factor on the amount of data that can be pulled out of archive on a given day. The outflowing 1X of data does not include any internal data exchanges indicated in the data flow diagram above; however, most of the 1X of inflowing data is generated either in the DAAC Science Processor or in MODAPS. The efficiency of the system will continue to be improved within the constraints of the available budget.

Levels 1A-B Science Processing

The Level 1 science processing is done on two 16-CPU SGI computers. There is plenty of CPU capacity for the MODIS Level 1 science processing, but the Science Processors are close to their input-output (I/O) capacity. However, Bruce Vollmer thinks that as his Science Integration group and Operations gain experience with this new system they, in coordination with the MODIS Team algorithm developers, will be able to make some refinements that will reduce the I/O load on the system. Both SGI machines will run together to do the required Level 1 processing. If one machine goes down because of a problem, then all the data flow will be routed to the other machine until the problem is fixed.

Basic Level 1 Science Processing Modules

DPREP

Preprocesses spacecraft orbit and altitude information

PGE01

Level 1A, reformats Level 0 data (12-bit data words go to 16-bit words) and does geolocation of each pixel to within + or – 100m

PGE02

Produces Level 1B at satellite MODIS radiances

PGE02A

Forms a Level 1B subset of MODIS radiances for the Clouds and Earth's Radiant Energy System instrument team at Langley Research Center

PGE03

Produces Cloud Mask and Atmospheric Profiles

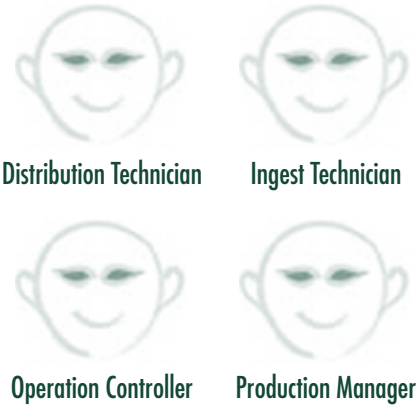
PGE71

Forms a Level 1A subset that is sent to the Ocean Team at the University of Miami

(PGE=Product Generation Executive, a science program packaged to work within the ECS System)

Operations Crew

Operations runs 24 hours a day to handle the large MODIS data stream. It has four stations.



Besides normal monitoring and control duties, the Operations crew control the processing mode or modes (OPS, TS1, and TS2) and handle any problems that arise. The Ingest, Production, and Distribution monitors oversee these specific modules of the V2 system. The data are archived on D3 tapes that are stored in silos. The tape system is automated so that the technicians archive and retrieve the data from their consoles. However, Archive managers-engineers make sure that the archive system works properly. Data are sent out to customers on 8mm tapes. The Operation Controllers watch the Servers, oversee the other positions, and watch the flow of data through the system. Customers pulling data from the DAAC not uncommonly get confused about their passwords and need help. In addition, the customer's server sometimes has trouble talking to the DAAC server, and the operators have to send advice and instructions. Occasionally there will also be some system failure and one of the DAAC servers stops communicating. This can affect one or all of the V2 system modules.

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Terra Is Up!

by Lee Kyle

— with information originating from the Terra status reports —

After years of careful preparations, a new generation of Earth science — one that studies Earth's land, oceans, air, ice, and life as a total global system — began with the picture-perfect launch 12/18/99 of the "Terra" spacecraft from Vandenberg Air Force Base, CA. Formerly known as "EOS AM-1," the Terra spacecraft lifted off at 1:57 p.m. EST on an Atlas IIAS rocket.

Liftoff took place at the very end of the 25-minute launch window to give officials time to analyze and verify wind direction and speed at the time of liftoff to allow the Atlas launch vehicle to safely steer the vehicle through upper level winds encountered during its climb to orbit. Just 14 minutes after liftoff, the Terra satellite separated from the Atlas rocket's second stage. Terra's flight computer and control subsystem quickly oriented the spacecraft so that Terra's instrument suite tracks Earth as it will during normal operations. The flight computer immediately moved on to the complex task of deploying Terra's state-of-the-art gallium arsenide solar array to supply power to the spacecraft and its instruments.

"We're extremely pleased with the launch," said Kevin Grady, Terra Project Manager at NASA's Goddard Space Flight Center, Greenbelt, MD. "The spacecraft is in good shape with all systems performing nominally. The mission is right on plan."

After launch both the Terra spacecraft and its payload of five scientific instruments went through a preparation and checkout period lasting a few weeks to ensure a long and productive observing lifetime. After the solar panels were deployed, several days were spent activating the spacecraft subsystems and initiating the preliminary instrument activation sequences. Both the spacecraft attitude system and its thrusters were checked out. In January four propulsion burns were initially scheduled to lift Terra from its initial orbit up to its final observing orbit at an altitude of 705 km above the nominal surface of Earth. During this checkout period a few potential problems were identified and fixed. The first orbit boosting burn didn't go quite as expected, and the remaining burns were delayed until the problem was resolved. The orbit boosting burns were successfully restarted in February. A second problem included a jitter in the tracking system of the high gain (data transmission) antenna when Terra passed through the South Atlantic Anomaly(SAA). This jitter tended to affect the spacecraft attitude. A software patch now turns off the high gain antenna tracking system motor when the satellite is in the SSA. This will not result in the loss of any data. The SSA is a local dip in Earth's magnetic field that channels high-energy particles down to spacecraft altitude. These energetic particles affect the sensors and electronic systems. By the second week in January all five scientific instruments had their outgassing heaters on. In the high vacuum existing at 705 km, residual gases absorbed in the surface environment by the instruments can outgas and contaminate the sensor surfaces. Thus, for several days before the sensors are uncovered to space the outgas heaters are turned on to bake out these gases. By January 6, all three MODIS door latches were released: nadir aperture, space view, and solar diffuser, but the doors remained closed. Because of the orbit boosting problem, the MODIS instrument will not start taking Earth viewing data until February.

The Terra spacecraft is roughly the size of a small school bus. It carries a payload of five state-of-the-art sensors that will study the interactions among Earth's atmosphere, lands, oceans, life, and radiant energy (heat and light). Each sensor has unique design features that will enable EOS scientists to meet a wide range of science objectives. Terra was placed in a circular Sun-synchronous near-polar orbit that descends across the equator at 10:30 a.m. when cloud cover is minimal and its view of the surface is least obstructed. The satellite altitude is 705 km, its orbital period is about

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98 minutes, and the orbit has an inclination of 98.2° to the equatorial plane. The life expectancy of the Terra mission is 6 years. It will be followed in later years by other EOS spacecraft that take advantage of new developments in remote sensing technologies.

The five scientific instruments on Terra are ASTER, CERES, MISR, MODIS, and MOPITT.

ASTER will obtain high-resolution (15-90 m), multispectral images of selected targets. It will collect data for only about 8 minutes per orbit. Given its high resolution and ability to change viewing angles, ASTER can produce detailed stereoscopic images.

CERES consists of two broadband scanning radiometers that will measure Earth's radiation balance and provide cloud property estimates to assess clouds' roles in radiative fluxes from the surface to the top of the atmosphere.

MISR will study the amount of sunlight that is scattered in different directions under natural conditions in four wavelengths (blue, green, red, and near-infrared). It will view Earth with cameras pointed at nine different angles: nadir, and forward and aftward view angles, at Earth's surface, of 26.1°, 45.6°, 60.0°, and 70.5°. As the instrument flies overhead, each region of Earth's surface is successively imaged by all nine cameras. It will also monitor atmospheric aerosols and clouds as well as land cover.

MODIS will view the entire surface of Earth every 1-2 days, making observations in 36 coregistered spectral bands (0.4-14.4 μm), at moderate resolution (0.25-1 km), of land and ocean surface temperature, primary productivity, land surface cover, clouds, aerosols, water vapor, temperature profiles, and fires.

MOPITT is a scanning radiometer employing gas correlation spectroscopy to measure upwelling and reflected infrared radiance in three absorption bands of carbon monoxide and methane. Its specific focus is on the distribution, transport, sources, and sinks of carbon monoxide and methane in the troposphere.

The instruments are commonly referred to by their acronyms, but for those interested their full names are

ASTER—Advanced Spaceborne Thermal Emission and Reflection Radiometer

CERES—Clouds and Earth's Radiant Energy System

MISR—Multiangle Imaging Spectroradiometer

MODIS—Moderate Resolution Imaging Spectroradiometer

This cool launch photo was lifted from the very excellent Terra Web Site; its color modified for inclusion here. Check out the original on the Web.

MOPITT—Measurements of Pollution in the Troposphere

Terra's sensors should begin collecting first images in February. These first images will be produced mainly to show that the sensors are working, but they will be of little scientific value as the sensors will not be calibrated at that time. Calibrated data are scheduled to be released about 2 months later. To obtain the data or additional information about any of it check the Web at

http://eosdatainfo.gsfc.nasa.gov/eosdata/terra/data_access.html

The Terra satellite was built by Lockheed Martin and assembled and tested at its spacecraft production facility in Valley Forge, PA. The Terra project is managed by NASA's Goddard Space Flight Center, Greenbelt, MD.

The interested reader is referred to the Terra Web site.

http://terra.nasa.gov/

The Heart of the DAAC
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Trouble tickets are routinely sent to the ECS Help Desk located nearby in Landover, MD. During the 1999 shakedown tests quite a few of the tickets described shortcomings in the original system. This input from Operations has led to refinements of the operations system and to increases in efficiency and speed. When a serious problem occurs, Operations first performs a triage to localize the source and then calls for help from the appropriate support groups. ECS maintains the basic ECS portion of the V2 system, while the science software in the Science Processor is the responsibility of Bruce Vollmer and his team. The GES DAAC Engineering group is responsible for the DAAC-unique extensions to the V2 system that they contributed.

V0 and V1 Operations

Liz Kennedy manages the operations of V0 (SeaWiFS plus heritage data products) and V1 (TRMM products) systems with the aid of a crew of 12 divided into 2 task groups led by Bob Rank (shipping and inventory and AVHRR Task Leader) and Kathie Rivas (Operations Task Leader and Data Support Team (DST) liaison). The V0 and V1 systems are smaller than the new V2 system but are similar in basic concept. Environmental data are ingested, archived, and then distributed to customers.

Bob Rank actually belongs to both Operations and the Goddard DAAC Land Biosphere DST led by Peter Smith. Bob leads the processing effort for the near real time AVHRR Land science products for this DST and assists with special requests from Biosphere data customers. He also oversees the shipping and inventory group that sends out orders that go by mail and handles the large volume of GES DAAC hardcopy products including data user's guides, general information pamphlets, and CD-ROMs. The inventory of paper user's guides is decreasing as the most popular ones are now available on the Web, but hundreds of CDs and paper documents are shipped each month as are hundreds of tape orders. A shipping and inventory group is also being set up for the V2 system, and its work will be coordinated with that of the V0-V1 group.

The members of Kathie Rivas's Operations group have been cross-trained to run both the V0 and V1 systems. Our latest operational procedure is to keep one set of folks on each system for a 2-week period, and then they swap. This way their training on each system won't be "forgotten." Because of this cross-training, one person can handle the tape orders for both systems. All the data in a system have to be ingested. The ingest procedure tells the system what the data are and also their characteristics, which include the times and Earth locations associated with the data. The old Nimbus data sets and the field experiment data have not been ingested into either the V0 or V1 systems. Tape orders for any of our noningested data are handled by Edee Ocampo, Operations' DST Liaison.

Senior Operations staff members, called ground controllers, are responsible for scheduling system activities, problem identification and resolution, interacting with the science and engineering staff, some configuration management, installing System Modification Requests into the operational baseline, data base queries and updates, participation in requirements definition for tools required by Ops staff, and all-around know-it-all about the systems.

The GES DAAC as an Integrated System

While Operations, also known as System Execution, is the DAAC heart, the other three DAAC components are equally essential; they are Engineering (a.k.a. system development or infrastructure), Data Support (a.k.a. Customer Service or DSTs), and Science Integration (they integrate science processing algorithms into the GES DAAC system). "The GES DAAC — How It Works," an article in *The Global Scanner* Summer 1999 issue, describes how all four components work together to form the working body of the GES DAAC. Many of our users don't see or even think about our Operations group. For instance, it is the Data Support group that sets up and maintains our Web pages and anonymous ftp site with the assistance of Engineering. But, like the heart, Operations is always there doing its vital work of bringing data into the Archive and then sending it out to our customers.

GES DAAC News

New Data Products

General News

People in the News

— as reported by George Serafino and the Customer Support Teams —

DATA PRODUCTS AND SERVICES

ATMOSPHERIC CHEMISTRY

Ozone and other trace gas compositions, dynamics, and energy interactions of the upper atmosphere.

New TOMS Ozone

The GES DAAC continues to archive the Level 2 and 3 Earth Probe TOMS ozone products delivered on a monthly schedule by GSFC's Atmospheric Chemistry and Dynamics Branch. The data can be accessed both from our nearline ordering system and by downloading from anonymous ftp. We also recently implemented a new feature on our Web site that allows a user to select all TOMS orbital "swaths" intersecting a geographical region of interest, then extract only those pixels contained within the region for output to a simple ASCII file. You can test this feature out at

http://daac.gsfc.nasa.gov/data/dataset/TOMS/01_Data_Products/01_Orbital/index.html

You can obtain access to our other ozone data sets at

http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/ATM_CHEM/ac_data.html

UARS Data Still Being Taken

Several instruments aboard the Upper Atmosphere Research Satellite (UARS) are still providing valuable measurements of trace gases, winds, and energy input into the upper atmosphere since launch in September 1991. The GES DAAC recently archived the version 20 SUSIM solar data, and continues to receive energetic particle data from the PEM instrument and species profiles from the HALOE instrument monthly. We also expect to receive more recent wind data from HRDI, and temperature, ozone, and chlorine monoxide profile data from the MLS instrument. Refer to the above URL for more information regarding access to these data sets.

ATMOSPHERIC DYNAMICS

3-D dynamic and thermodynamic state of the Earth-atmosphere system, from satellite measurements and assimilation systems.

Online Subsetting

Users of the GES DAAC's TOVS Pathfinder and Assimilation Time Series data sets may be interested in the online subsetting feature that has been implemented for the products resident on anonymous ftp. The feature allows both regional subsetting and parameter selection (for those files containing multiple levels) for a specified time range, with the extracted data being directed to either a simple flat binary or ASCII output file. The process is performed in the foreground and permits the user to download the results immediately to his or her local workstation upon completion. Try out the TOVS subsetter at

http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/atmospheric_dynamics/ad_tovs_datasets.html

(click on the Online Subsetting links near the top of the page) and the Assimilated Data Subsetter at

http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/atmospheric_dynamics/ad_dao_datasets.html

(click on Online Subsetting of Timeseries Gridded Data)

Coming: 1° Resolution Data Assimilation Products

The same DAAC Data Team that has provided such a high level of service for our heritage Data Assimilation products are preparing to receive a new suite of products from the next generation assimilation system (GEOS-AM1, Goddard Earth Observing System for Terra) being run at Ames Research Center under the direction of GSFC's Data Assimilation Office. This new model will be run at higher resolution (1° versus 2° x 2.5°) and will consist of First Look (1 day delay), Late Look (2 week delay) and Final Platform products, the latter of which assimilates data from EOSDIS platforms. More details will follow in *The Global Scanner* Spring 2000 issue.

FIELD EXPERIMENTS

Aircraft and ground based measurements of meteorological variables designed to improve science algorithms and validate satellite-derived data products.

Nothing to report at this time.

HYDROLOGY

Global precipitation, its variability, and associated latent heating, important for studying the global hydrological cycle, climate modeling, and applications.

TRMM Data's Second Major Reprocessing

The second major reprocessing of the TRMM data products by the TRMM Data and Information System (TSDIS) is already underway, with version 4 files gradually being replaced by the equivalent version 5 files at the GES DAAC. At the current reprocessing rate of approximately four times normal processing, all of the version 4 data should be replaced by midsummer 2000. In the interim, a mixture of versions will be visible through our WWW User Interface. TRMM data can be searched and ordered at

http://lake.nascom.nasa.gov/data/dataset/TRMM/index.html

Geostationary Satellite Products

As part of the GES DAAC's support for TRMM and TRMM-related Field Experiments, we are collecting visible and IR channel data from several geostationary satellites daily. Courtesy NOAA/NESDIS, near real-time images are now available for GOES, GMS, and Meteosat on the Web at

http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/hydrology/satel.realtime.html

GOES data covering the U.S. are updated every 15 to 30 minutes, GOES global every 3 hours, GMS global every hour, and Meteosat global four times a day.

INTERDISCIPLINARY

Global land, ocean, and atmospheric parameters mapped to uniform spatial and temporal scales for basic research and applications studies.

Nothing to report at this time.

LAND BIOSPHERE

Long time-series vegetation and thermal infrared brightness temperature data sets for global change research.

New Vegetation Data

The AVHRR Land Pathfinder team is now processing new AVHRR GAC data in near real time and making the derived vegetation products available as HDF files in the DAAC tape archive and as binary data (global, continental, and regional area files) on our ftp site. We are also processing a span of historical data (1995-1998) and by January 2000 we plan to provide a set of vegetation products, processed with a self-consistent algorithm, that covers the entire period 1981-present. Work in progress includes a new AVHRR Land CD-ROM and the creation of a time-ordered, spatially tiled version of the full 8 km data set. More details will follow in the next issue.

On-the-Fly Subsetting

This option has been implemented for the DAAC's online AVHRR continental data products. It is similar to the TOVS and DAO subsetter mentioned earlier and allows a user to define a spatial area of interest, time period, and parameter group and then produce custom subsets for that spatial region. Users may then use ftp to download tar files for each selected parameter. You can access this feature at

http://daac.gsfc.nasa.gov/data/dataset/AVHRR/01_Data_Products/04_FTP_Products/01_ftp_subsets/index.html

MODIS DATA SUPPORT

Radiance data and auxiliary information such as geolocation and cloud mask, atmospheric profiles, and higher level ocean color data.

With the launch of the Terra spacecraft 12/18/99, the GES DAAC has been very busy preparing for receipt of data from the Moderate Resolution Imaging Spectroradiometer (MODIS). We will be responsible for processing the Level 1A and 1B radiance data, auxiliary information such as geolocation and cloud mask, and the atmospheric profile product. Other higher level ocean color products (e.g., chlorophyll, water-leaving radiances) and atmospheric products (e.g., aerosols, cloud properties) will be processed externally and delivered to the GES DAAC daily. The data will not be immediately available to the general user community pending instrument checkout and subsequent validation by the various science team members and algorithm developers. Check out the GES DAAC's MODIS information pages at

http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/MODIS/html/mdst.html

for more details regarding data products and how to access them when they become available to the public.

OCEAN COLOR

Remote sensing ocean color data used to investigate ocean productivity, marine optical properties, and the interaction of winds and currents with ocean biology.

New High Resolution Subsets

The GES DAAC continues to add new High Resolution Picture Transmission (HRPT) regional subsets to its inventory of ocean color products. Currently there are eight such subsets encompassing the U.S. and Canadian east coast, the U.S., Canadian, and Mexican west coast, and the Black Sea and Mediterranean Sea regions of Europe. The files contain 1 km resolution calibrated radiance data collected by 3 HRPT stations. More details can be found at

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http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/OCDST/OB_Data.html

North Atlantic Bloom

Check out our Science Focus Web based series of articles highlighting noteworthy phenomena observed by the SeaWiFS instrument. Numerous illustrative images pertaining to the feature of interest accompanies the descriptive text. The latest article (November 1999) deals with the North Atlantic Bloom, apparently the only page on the Web to discuss this phenomenon. You can view the Science Focus pages at

http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/OCDST/science_focus.html

SeaWiFS Reprocessing

The GES DAAC is gearing up for the second major SeaWiFS reprocessing to begin in the spring 2000 time frame. In addition to incorporating improvements in the Level 2 algorithms used for deriving important quantities such as chlorophyll content, several new parameters will be introduced. These include the water leaving radiance at 670 nm and the so-called Angstrom exponent, which characterizes background aerosol scattering contributions to the satellite observed radiances. As Dr. Charles McClain (the Project Scientist) noted, some of the current suite of geophysical parameters will be deleted and replaced by new ones, so data users may find it necessary to update their own data processing software. For further information contact

ocean@daac.gsfc.nasa.gov

for the latest news regarding the reprocessing.

For more details about the GES DAAC data holdings and to order data see our Home Page or contact us by e-mail, phone, or fax.

http://daac.gsfc.nasa.gov/

e-mail: daacuso@daac.gsfc.nasa.gov
voice: 301-614-5224
fax: 301-614-5268

GENERAL NEWS

Publication

Peter Noerdlinger's paper, "Atmospheric refraction effects in Earth remote sensing," will appear shortly in the ISPRS *Journal of Photogrammetry & Remote Sensing, Vol. 1155.* Refraction slightly distorts the view of Earth from space, as well as affecting the angle at which sunlight or moonlight illuminates its surface. The space observer's problem is to obtain the true (refracted) surface zenith angle (z') of illumination or of viewing, when the zenith angle (zo) of the ray in space is known, and to correct for the apparent horizontal displacement of the surface point being viewed. This paper solves the problem of the refraction angle for a spherical atmosphere by a simple, analytic solution. The problem of the apparent horizontal displacement of the point viewed is also solved analytically, but approximately, because the result depends weakly on an assumed vertical structure of the atmosphere. For sea level observations in visible light at 30° zenith angle, the refracted angle is only 0.01° and the observed point is displaced by only 2.2 m, but at a rather extreme unrefracted zenith angle of 86°, the refraction is 0.32° and the displacement nearly 5 km.

Presentations

A.K. Sharma, Greg Leptoukh, and **George Serafino** presented the poster paper "MODIS Data Support at the Goddard Earth Science DAAC." The paper outlines the services and procedures that the Goddard Earth Science (GES) DAAC has set up to distribute the MODIS data products to the user community. A brief sketch of the characteristics of the MODIS instrument and of its many data products is included. Emphasis is placed on the ocean and atmospheric products the GES DAAC will distribute.

AGU Ocean Sciences 2000 Meeting in San Antonio, Highlights

The American Geophysical Union Ocean Sciences meeting in the last week of January featured several sessions in which ocean color research was at the forefront. Both the SeaWiFS project and the DAAC had an exhibit booth at the meeting.

Monday, January 23, morning and afternoon:

Use of Remotely Sensed Data in Marine Carbon Cycle Studies (the morning session began with a review of the first 2 years of the SeaWiFS mission by Project Scientist Dr. Charles McClain).

Tuesday, January 24, afternoon:

James Acker, Greg Leptoukh, Suhung Shen, Yiping Wang, Robert Simmon, and **Robin Williams** presented "A Day in the Life of the Ocean Color Data Support Team," a behind-the-screen description of both the data system and the people who work with it. This was in the Ocean Optics and Remote Sensing Poster Session.

Thursday, January 26, afternoon:

Remote Sensing of the Ocean. Following this session, the GES DAAC offered a training session intended primarily for new users interested in the use of ocean color data for coastal regions and marine conservation. (Experienced users probably didn't learn anything new here.) The training session ran from approximately 5:30–7:30 P.M.

GES DAAC Stats

DATA HANDLED IN GIGABYTES DURING 1999

	INGESTED			DISTRIBUTED			
Month	TRMM	Other	Total	ftp	Media	CDs	Total
JAN	604.9	61.7	668	345.5	1444.3	3615.9	5406
FEB	614.9	52.0	667	363.4	1468.5	7030.4	8862
MAR	571.8	86.2	658	304.8	2591.0	5736.2	8632
APR	347.7	58.2	406	478.4	1927.2	4827.7	7233
MAY	371.9	158.5	530	336.0	1139.4	4184.3	5660
JUN	242.7	125.0	368	259.0	2288.5	2476.5	5024
JUL	249.0	80.4	329	382.2	1362.0	2531.0	4275
AUG	279.7	130.5	410	599.6	2759.4	1680.9	5040
SEP	251.0	81.8	332	357.5	2472.9	606.7	3437
OCT	238.2	111.8	350	246.6	1267.4	1125.7	2640

Almost all the ingested data and most of the data distributed by ftp and media refer to compressed data sets. The uncompressed data volumes would be two to three times larger.

PEOPLE IN THE NEWS

Congratulations!

Jim Acker and his wife Dorothy welcomed the birth of twins, Benjamin and Audrey, in October, and also welcomed their adopted daughter from China, Natalie, in November. Jim wishes to express his appreciation for the best wishes and support of all the DAAC staff.

Well done, Gilberto Vicente

The rainfall rate algorithm for flash flood applications Gilberto developed while working for NOAA/NESDIS has gone through crucial tests recently. Here are some results and conclusions from a report (11/8/1999) by Rod Scofield of NOAA.

GOES Assessment Meeting on the Auto-Estimator (AE)

Rod Scofield participated and made a presentation at the GOES Assessment Meeting on the Auto-Estimator (AE) at COMET (the Cooperative Program for Operational Meteorology, Education, and Training). The primary purpose of the meeting was to review

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the September 1-October 15 field test of the AE and decide whether or not the AE was ready for operational implementation and the Advanced Weather Interactive Processing System (AWIPS). All of the National Weather Service representatives at this meeting (Eastern, Central, Southern, and Western) agreed the AE should be implemented operationally and made available on AWIPS as soon as possible — hopefully by spring or summer 2000. The Satellite Analysis Branch (SAB) will be using the AE operationally for cold and warm tops. SAB will quality control the AE and will have the ability to manually override/adjust the rain rate curve, if the AE is not properly handling the convective systems. The forecast/user community will have to have access to training modules on the strengths, weaknesses, and limitations of the AE. All of the participants were enthusiastic that the AE will soon evolve into a multispectral and multisensor precipitation algorithm. Congratulations are in order for the principal developer of the AE, **Gilberto Vicente**, and to Clay Davenport and Shuang Qiu for their efforts in making the AE acceptable for operations.

Welcome Long Pham

In September 1999 Long Pham joined the GES DAAC government staff working in the Engineering Group headed by Chris Lynnes. (He shares Room S150B with Chris.) At present he is working on the interoperability problem with the George Mason University (GMU) Seasonal to Interannual Earth Science Information Partner (SIESIP), which is a consortium involving GMU, the University of Delaware, the Center for Ocean-Land-Atmosphere (COLA) Studies, and the GES DAAC. About himself he says,

"I was born and spent the early part of my life in Saigon, Vietnam. In April 1975 my family fled our country, when the communists took over, and came to Albuquerque, where my aunt and uncle were living. I graduated from the University of New Mexico in 1991 and started my career as a computer engineer with NASA-Langley Research Center in Hampton, VA. In September 1999 I relocated to NASA-Goddard Space Flight Center, working for the DAAC.

"I enjoy mountain biking, photography, surf fishing, tennis, and reading during my spare time. In the past I also enjoyed tutoring young Vietnamese children in the areas of science, math, computers, and English. As soon as I get properly settled in this new job and this new location, I plan to start doing it again."

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